

Estuarine Education and National Review of State Standards

Dan Barstow

Martos Hoffman

TERC
Center for Science Teaching and
Learning

NOAA EDUCATION COUNCIL MEETING

November 15, 2006

An aerial photograph of a river delta, likely the Mississippi River delta, showing a complex network of distributaries and a large body of water at the bottom. The text is overlaid on the image.

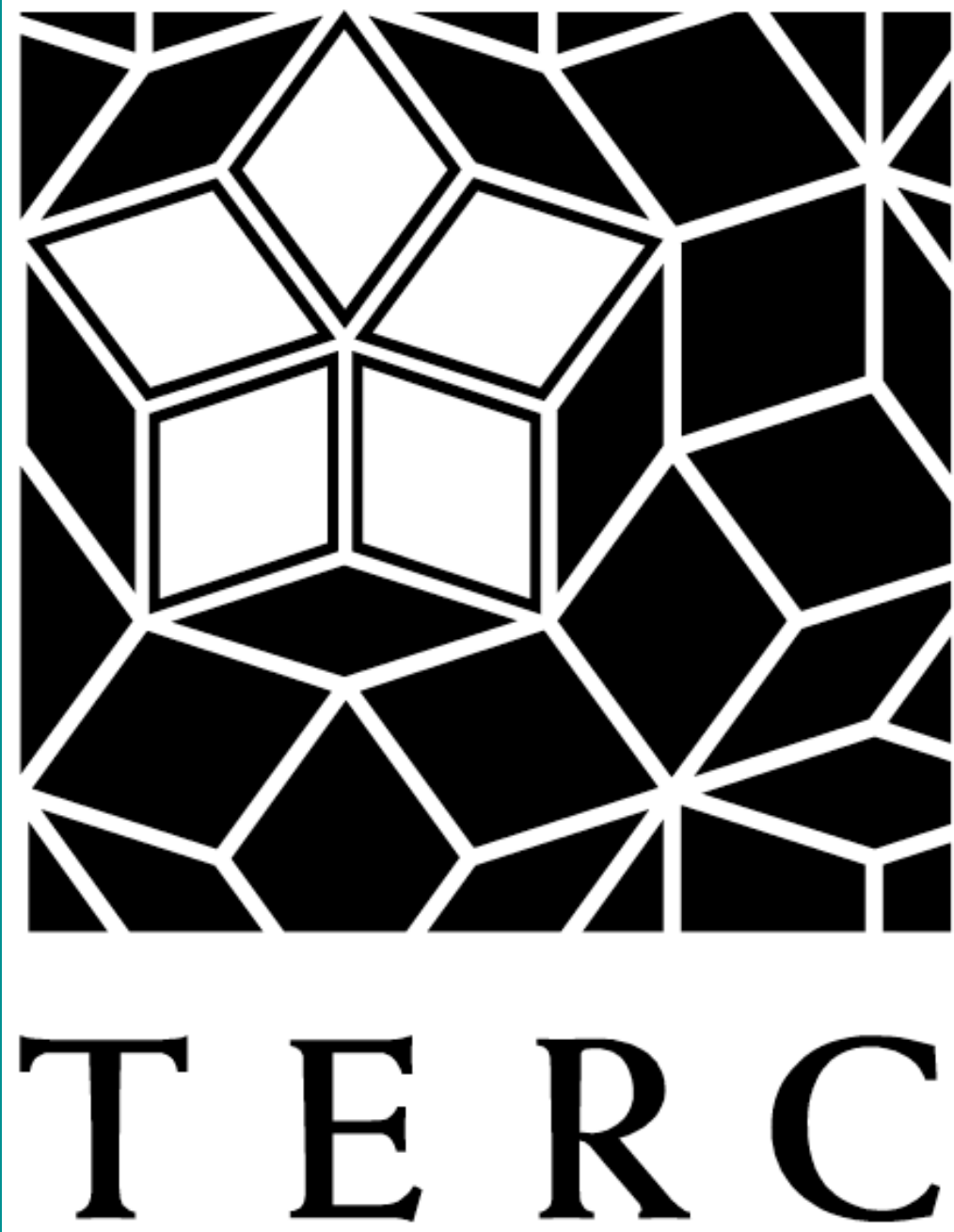
Part 1

Science Standards and Estuaries Education

Dan Barstow

An aerial photograph of a coastal estuary. A river flows from the bottom left towards the center, where it meets a large, shallow, irregularly shaped body of water. The surrounding landscape is a mix of green wetlands and brownish sandy areas. In the background, a wide, light-colored sandy beach stretches across the top of the image, with waves breaking on the shore under a clear blue sky.

Excellence in Estuaries Education







Wading B.I.R.D.S



Wading birds are tall leg birds that spend a lot of time in water. They have long necks and long bills. They are often found in wetlands and marshes. They are important for the food chain and for the environment.











Chesapeake Bay Coastal Bays Rivers & Streams Watersheds



MARYLAND
DEPARTMENT OF
NATURAL RESOURCES



**Eyes
on the
Bay**



www.eyesonthebay.net

Presented By:








Tidewater Ecosystem Assessment



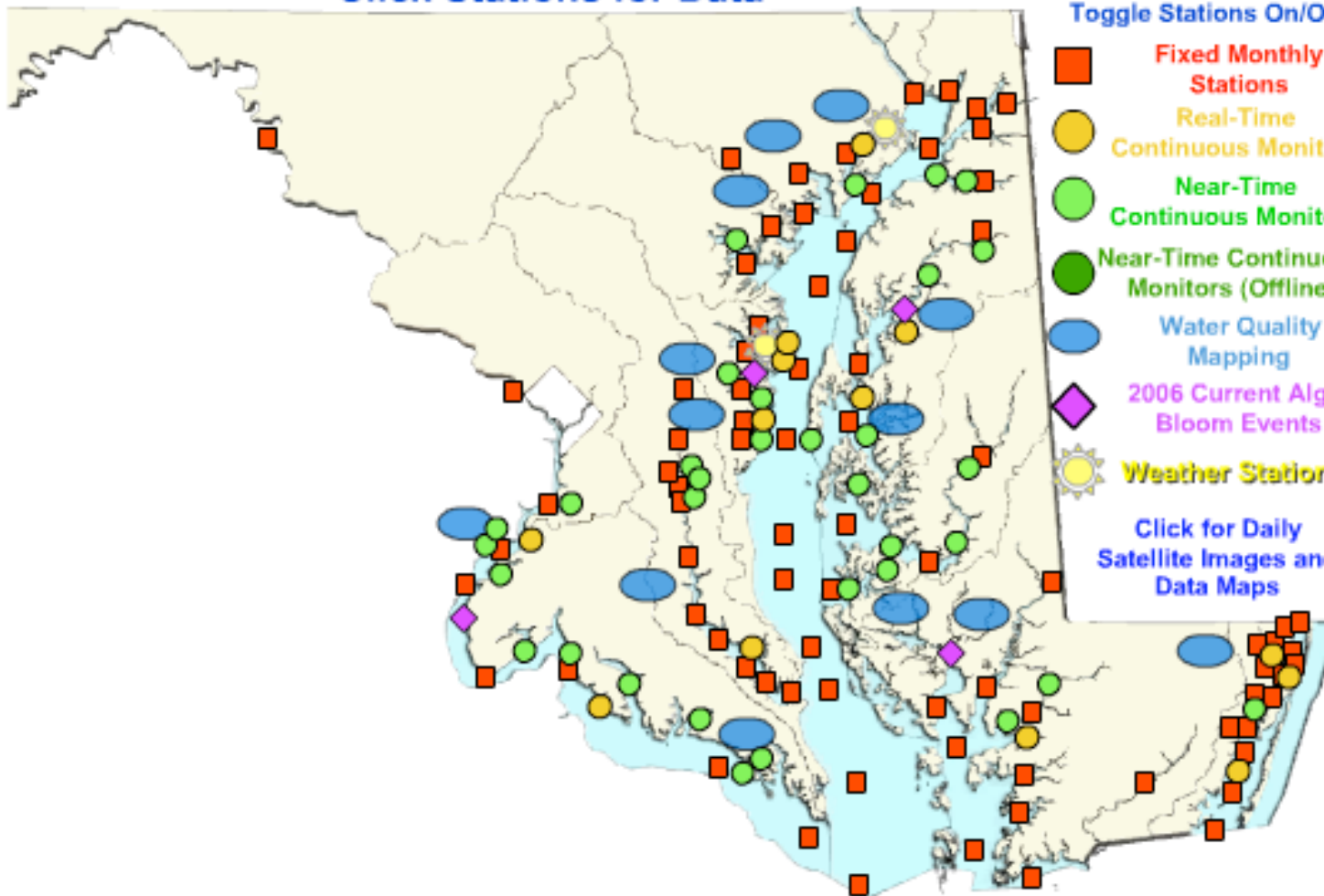
**Impact of Tropical Storm Ernesto
and subsequent rain event,
September 2006**

Click Stations for Data

Click Legend Symbols to
Toggle Stations On/Off

-  **Fixed Monthly Stations**
-  **Real-Time Continuous Monitors**
-  **Near-Time Continuous Monitors**
-  **Near-Time Continuous Monitors (Offline)**
-  **Water Quality Mapping**
-  **2006 Current Algal Bloom Events**
-  **Weather Stations**

Click for Daily
Satellite Images and
Data Maps



*What amazing
learning opportunities!*

Students learn:

Physics	- wave motions
Biology	- diverse habitats
Chemistry	- salinity variations
Earth Sci	- tidal cycles
Observation	- using all the senses
Inquiry	- sparking curiosity
Technology	- access to data
Big ideas	- Earth as a system
Math	- quantitative analysis
Language	- communicating ideas
Team skills	- helping others explore

. . .and so much more. . .

Challenge #1 - Perception of Scope

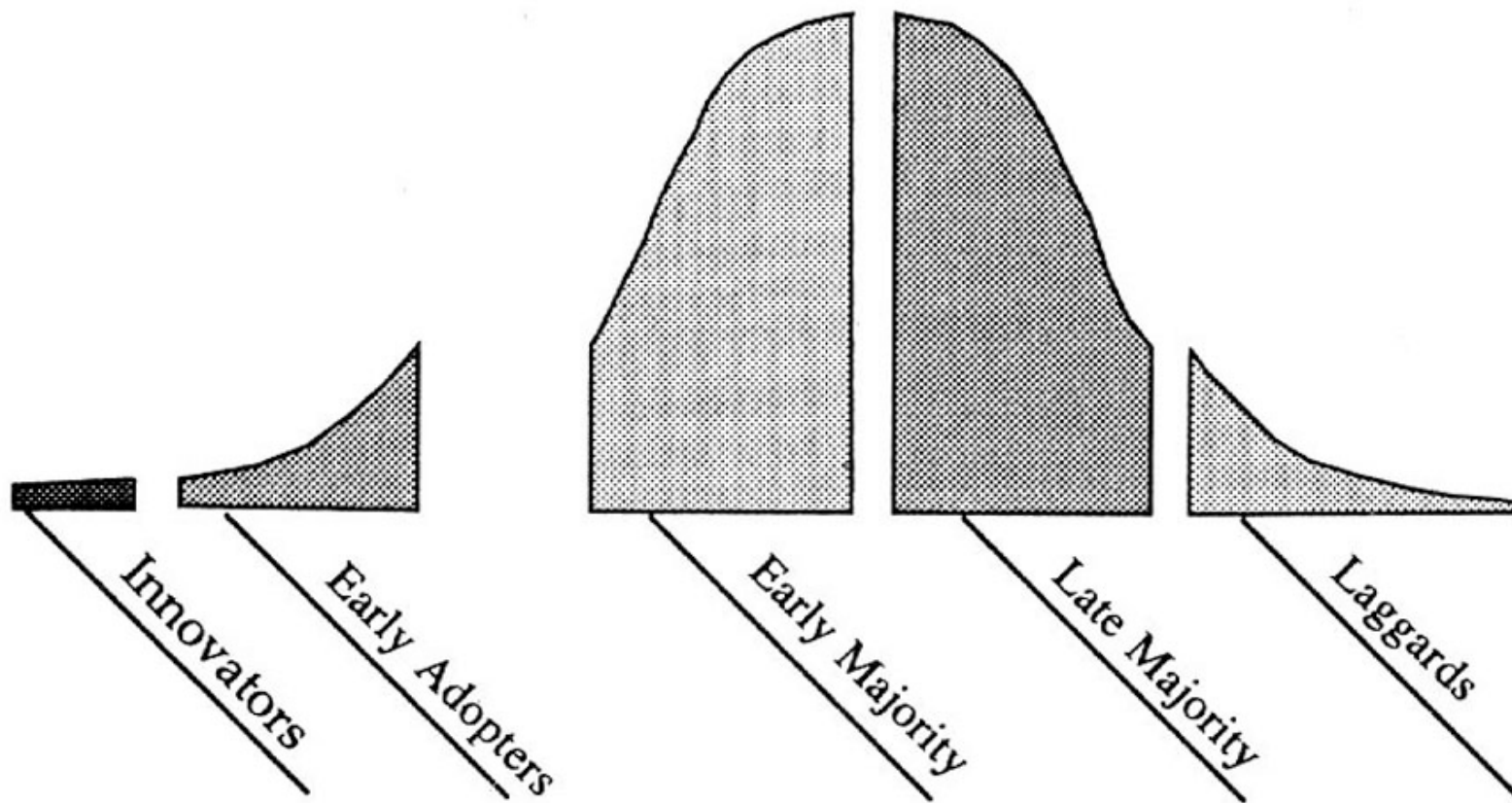
estuaries

or

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. . .and so much more. . .

The *Revised* Technology Adoption Life Cycle



From *Crossing The Chasm* by Geoffrey A. Moore

Part 2

NOAA Domains Within State Science Standards

Martos Hoffman



Revolutionizing Earth System Science Education for the 21st Century



50-State Analysis of Earth Science
Education Standards



Blueprint for Change: Report from the National Conference on the

Revolution

in Earth and Space Science Education

"As our nation deliberates on education policy and funding, we, as leading science educators and scientists, call for legislators, decision makers, and stakeholders to implement all measures that support science education in general and earth and space science in particular.

Fueled by new technologies over the last 40 years, advances in Earth and space science are revolutionizing our understanding of Earth's systems and processes. This growing understanding is increasingly needed to inform political and economic decisions of local, national and global impact.

For this reason, a science-literate citizenry is vital to the nation's well-being and security and will insure our nation's continued leadership in science and technology in the 21st century. To empower the public to make sound and reasoned choices, earth and space science must be taught throughout the United States in K-12 classrooms and be accessible to all students."

Revolutionary Earth System Science

1. Earth as system
2. Inquiry-based learning
3. 21st century technology
4. Space-age perspective



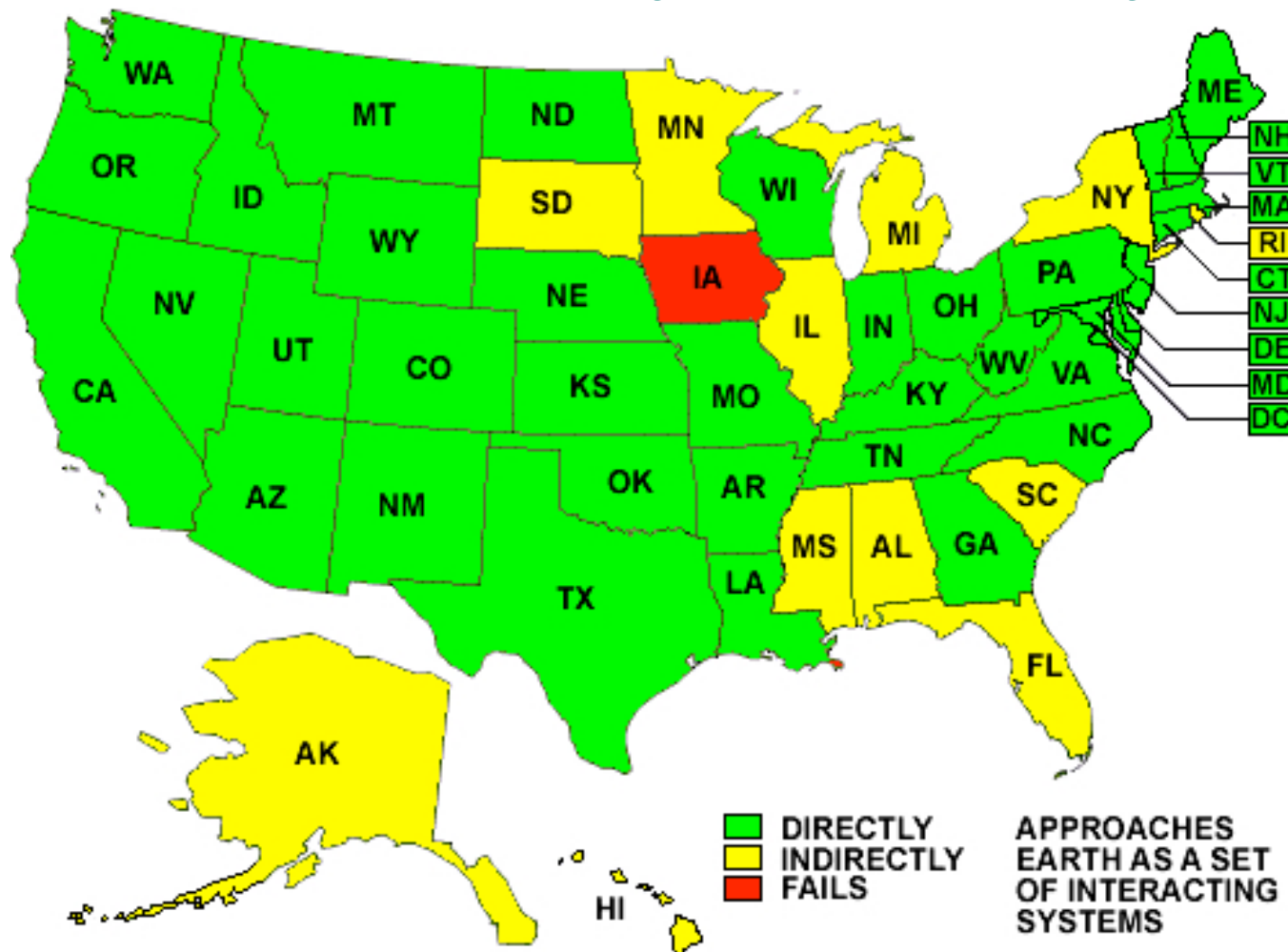
NOAA's Strategic Domains

- Ocean literacy
- Atmosphere, weather, climate
- Environmental literacy

Earth As a Dynamic Integrated System

National Grade: B+

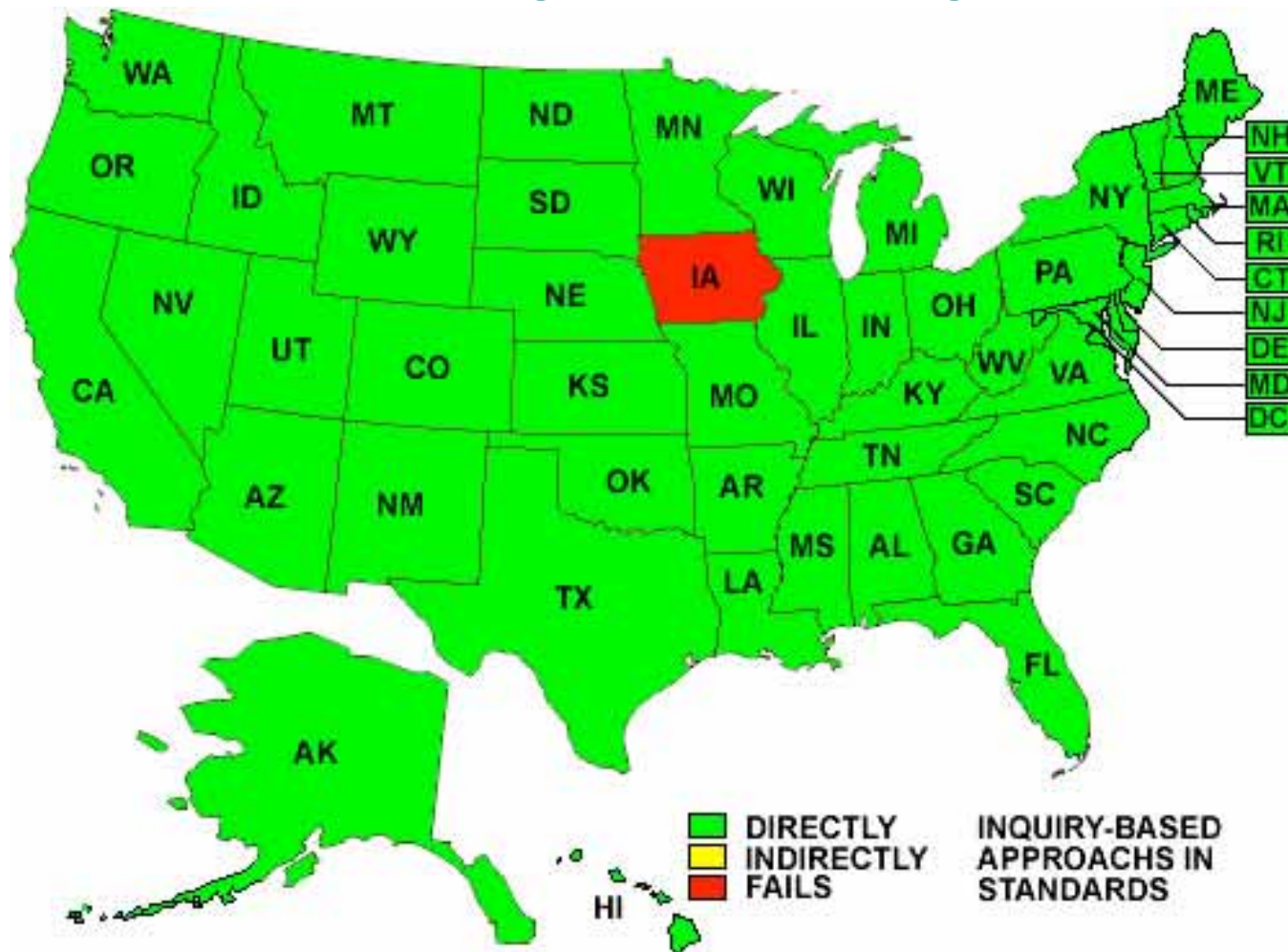
- Most states include systems
- Some states feature systems as a key approach



Inquiry-Based Learning

National Grade: A

- Every state with standards employs inquiry-based learning to some degree

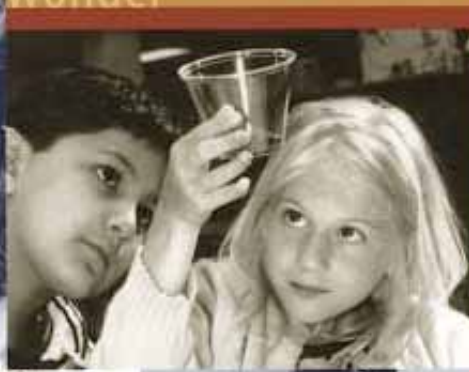


NATIONAL
SCIENCE
EDUCATION
STANDARDS

understand



wonder



assess



interact



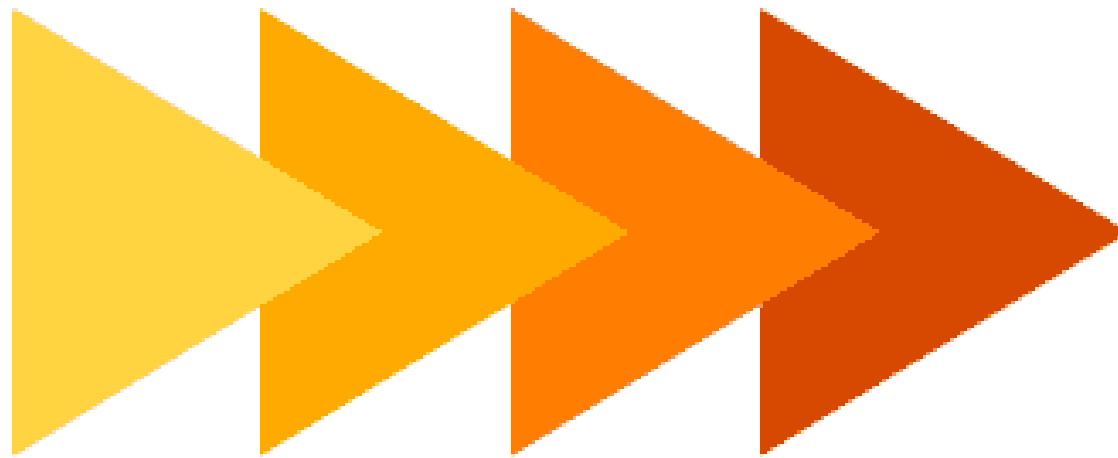
encourage

explore

NATIONAL RESEARCH COUNCIL

B E N C H M A R K S

F O R S C I E N C E L I T E R A C Y



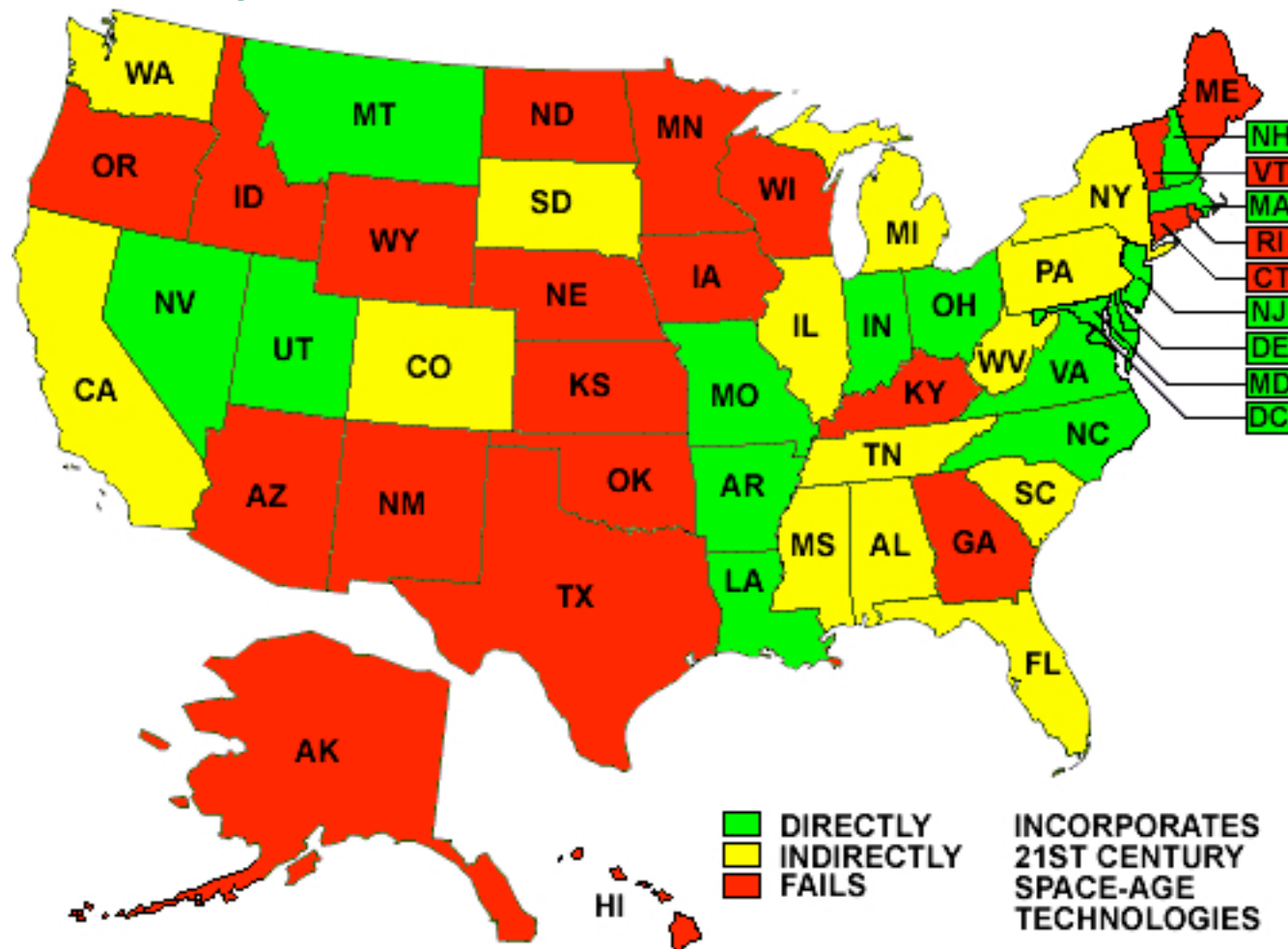
A M E R I C A N A S S O C I A T I O N F O R T H E A D V A N C E M E N T O F S C I E N C E

P R O J E C T 2 0 6 1

21st Century Technology

National Grade: D+

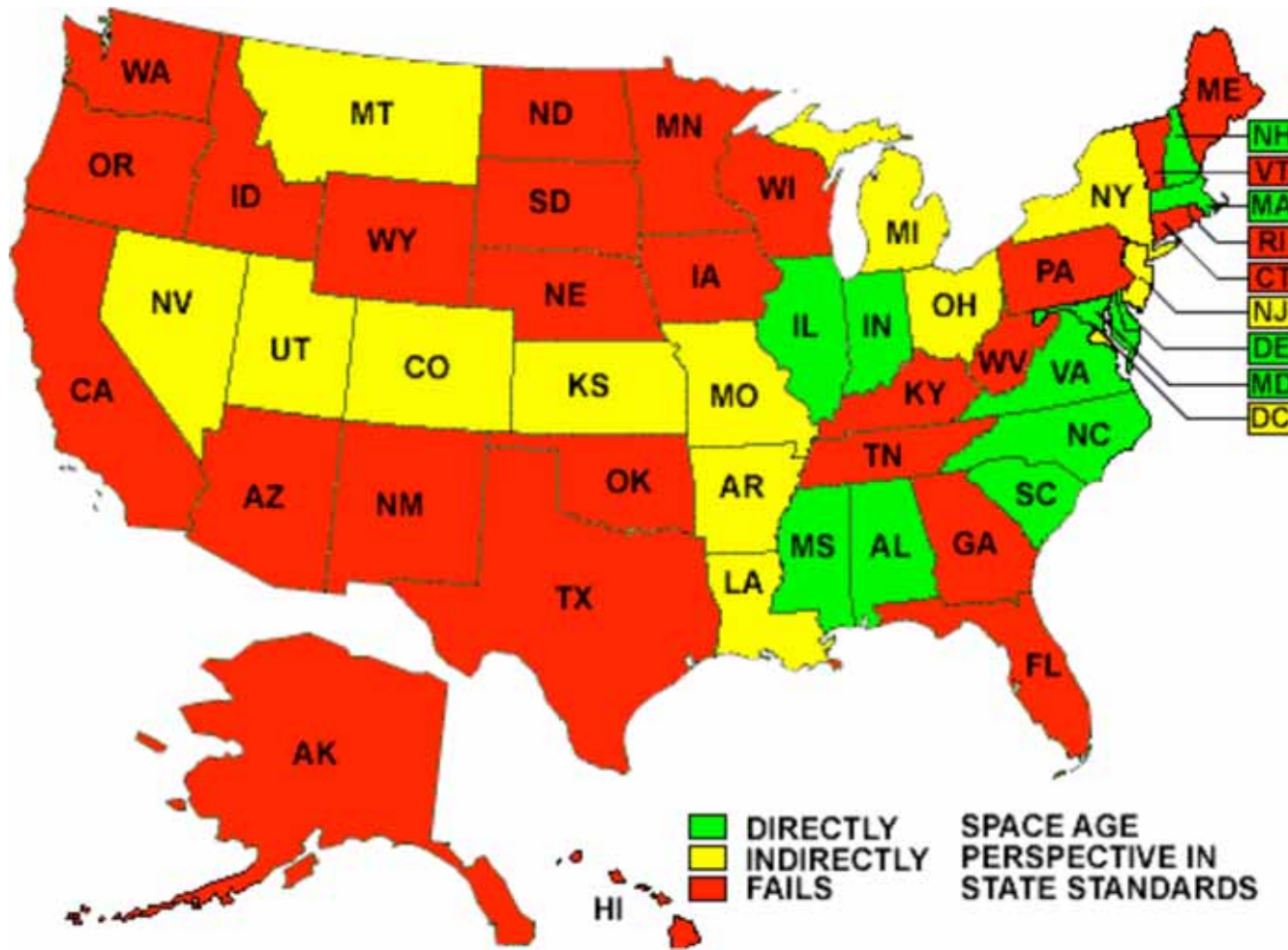
- One-third directly incorporate 21st technology
- Nearly half fail to include 21st technology



Space-Age Perspective

National Grade: D

- About one-fourth directly include space-age
- More than half fail to include in standards



TEACHING SCIENCE THROUGH SCIENCE IS SUPPORTED BY FUNDAMENTAL CONCEPTS COMPARABLE TO THOSE UNDERLYING THE NATIONAL SCIENCE EDUCATION STANDARDS (NSES). CONSULT THE OVERVIEW MATERIALS PROVIDED TO INTEGRATE OCAH LITERACY INTO YOUR CURRICULUM.

- The **coast** is the distinctive physical features on our planet Earth—covering approximately 70% of the planet's surface. There is one coast with every ocean basin, such as the North Pacific, South Pacific, North Atlantic, South Atlantic, Indian and Arctic.

- An ocean basin's size, shape and features (shoals, trenches, red-coar ridges, rift valleys) vary due to the movement of Earth's lithospheric plates. Earth's highest peaks, deepest valleys and furthest water plains are all in the ocean.
- Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of the Earth's rotation (Coriolis effect), the Sun, and water density differences. The shape of ocean basins and adjacent land masses influence the path of circulation.



THE OCEAN FROM SPACE. Photograph from NASA's Columbia Orbiter Vehicle shows Somalia's coast, South Yemen and the Gulf of Aden toward the top and the Indian Ocean to the right.

- Most of Earth's water (97%) is in the ocean. Lowercase the oceans are **saline** (salty). The remaining part is slightly less than three-tenths, its density is slightly higher, its electrical conductivity is much higher, and it is slightly basic. The salt in seawater comes from leaching and volcanic activities, erosion of the surface, and atmospheric deposition.
- The ocean is an integral part of the water cycle and is connected to all of the earth's water masses via evaporation and precipitation processes.
- The ocean is connected to major seas, waterbodies and waterways because of major waterbodies on each side of the ocean and creating, therefore, waterways, salt sediments and columns from waterbodies to estuaries and to the coasts.
- Although the ocean is large, it is finite and resources are limited.

COASTAL CARVING: The Big Sur coastline in California is the result of a great geological uplifting which occurred roughly 20 million years ago.

- Many earth materials and geochemical cycles originate in the ocean. Many of the sedimentary rocks now exposed on land were formed in the ocean. Coarse life laid down the vast volume of siliceous and carbonate rocks.
- Sea level changes cause time the expanded and contracted continental shelves, created and destroyed island seas, and shaped the surface of land.
- Deserts – the wearing away of rock, soil and other biotic and abiotic materials – occurs in coastal areas as well as inland, and currents in rivers and in the oceans remove sediments.
- Small amounts of life live in plants, trees, insects and animals. Most beach sand is derived from their hard exoskeletons.



- carried to the coast by rivers, but sand is also eroded from coastal sources by surf. Sand is redistributed by waves and coastal currents seasonally
- Tectonic activity, sea level changes, and force of waves influence the physical structure and bathymetry of the coast

- The ocean controls weather and climate by distributing the Earth's energy, water and carbon systems.
- The ocean absorbs part of the solar radiation reaching Earth. The ocean loses heat by evaporation. This heat loss drives atmospheric circulation when, after it is mixed into the atmosphere as water vapor, it condenses and forms rain. Condensation of water evaporated from warm seas provides the energy for hurricanes and cyclones.
- The El Niño Southern Oscillation causes important changes in global weather patterns because it changes the way heat is passed to the atmosphere in the Pacific.

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NATURAL PHENOMENON. A rotating column of air (similar to a tornado) crashes this way atop in the Gulf of Mexico near an offshore oil rig.

- 4 Measure the flux on land originally exposed from the tropical ocean.
- 5 The ocean dominates the Earth's carbon cycle. Half the primary productivity on Earth takes place in the surface layers of the ocean and the ocean absorbs roughly half of all carbon dioxide added to the atmosphere.
- 6 The ocean has had, and will continue to have, a significant influence on climate change by absorbing, storing, and moving heat, carbon and water.
- 7 Changes in the ocean's circulation were produced largely

- Most of the oxygen in the atmosphere originally came from the activities of photosynthetic organisms in the ocean.
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CORAL REEF HABITAT. A fisherman tries his luck with a shrimp net in a mangrove swamp.

6. Most life in the ocean exists as microbes. Microbes are the most important primary producers in the ocean. Not only are they the most abundant life forms in the ocean, they have extremely fast growth rates and life cycles.

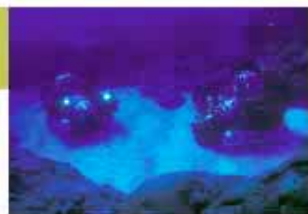
- Once life began in the sea from the reactants you got the biggest output that we live on Earth, the whole world.
- Most life in the ocean exists as a protists. Marine are the most important primary producers in the ocean, but only are the most abundant life forms in the ocean, they have extremely fast growth rates and life cycles.
- Some primary producers are found exclusively in the ocean. The diversity of major groups of organisms is much greater in the ocean than on land.
- Ocean biology provides many unique examples of life cycles, such as the alternation of generations among organisms (protists, predator-prey dynamics and energy transfer) that do not occur on land.
- The ocean is a three-dimensional surface that living space and diverse habitats from the surface through the water column to the seafloor. Most of the living space on Earth is in the ocean.
- Ocean habitats are defined by environmental factors.
 - On the basis of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, currents, substrates and circulation, ocean life is not evenly distributed temporally or spatially, as it is "patchy". Some regions of the ocean support more diverse and abundant life than others. On land, we can see the same pattern in the form of a desert.
 - There are deep ocean ecosystems that are independent of energy from sunlight and photosynthesis (hydrothermal vents, submarine hot springs, methane cold seeps, and whale falls) as only on chemical energy and chemosynthesis organisms can survive.
- Tides, waves and pressure cause vertical positional patterns along the shore, influencing the distribution and diversity of organisms.
- Grazing: provide important and productive energy



PACIFIC DOGSYSTEM An odorous sea star makes a kelp forest home in Monterey, Bay, California.

- 3 The ocean affects every human life. It supplies freshwater (most rain comes from the ocean) and nearly all Earth's oxygen. It moderates the Earth's climate, influences our weather, and affects human health.
- 4 From the ocean we get food, medicine, and mineral and energy resources. In addition, it provides jobs, supports our

- The ocean affects every human life. It supplies freshwater to the planet, protects us from the coast and nearby all Earth's oxygen. It influences the Earth's climate, influences our economy, and affects human health.
- From the ocean we get fish, medicines, and mineral and energy resources. In addition, it provides jobs, supports our culture, and serves as a source of recreation and inspiration of good people and places, a place in national identity.
- The ocean is a source of inspiration, recreation, relaxation and discovery. It is also an important element in the heritage of many cultures.
- Much of the world's population lives in coastal areas.
- Humans affect the ocean in a variety of ways. Laws, regulations and resource management activities have been created and pursued to protect human development and activity while to produce a more ocean resource conservation and management, and modifications in response to beaches, shores and reefs. In addition, humans have improved much of the large vegetation from the coast.
- Coastal regions are susceptible to natural hazards (tsunamis, hurricanes, cyclones, sea-level change, and storm surge).
- Everyone is responsible for caring for the coast. The ocean affects life on Earth and humans must live in ways that sustain the coast, individual and collective actions are needed.



UNDERWATER EXPLORATION. Deep Worker submersibles explore the Flower Garden Banks National Marine Sanctuary in the Gulf of Mexico.

- 1 The ocean is the last and largest unexplored place on Earth—less than 5% of it has been explored. This is the great frontier for the next generation's explorers and researchers, whom they will find great opportunities for inquiry and investigation.

Over the last 40 years, use of ocean resources has increased significantly, therefore the future sustainability of ocean resources depends on our understanding of those resources and their potential limitations.

- Over the last 40 years, the use of modern resources has increased significantly, therefore the future availability of some resources depends on our understanding of those resources and their potential and limitations.
- New technologies, weapons and tools are expanding our ability to explore the cosmos. Cosmochemists are relying more and more on satellites, different boats, submarines and observatories to understand the universe.
- Use of mathematical models is now an essential part of many sciences. Models help us understand the complexity of the cosmos and of its interaction with Earth's climate. They process observational data and help describe the phenomena in various systems.
- Cosmic exploration is truly interdisciplinary; it requires close collaboration among biologists, chemists, climatologists, computer scientists, engineers, geologists, meteorologists, physicists and many other disciplines.



THE DAY'S CATCH: A commercial fishing vessel off the coast of Santa Cruz, California, returns to port.

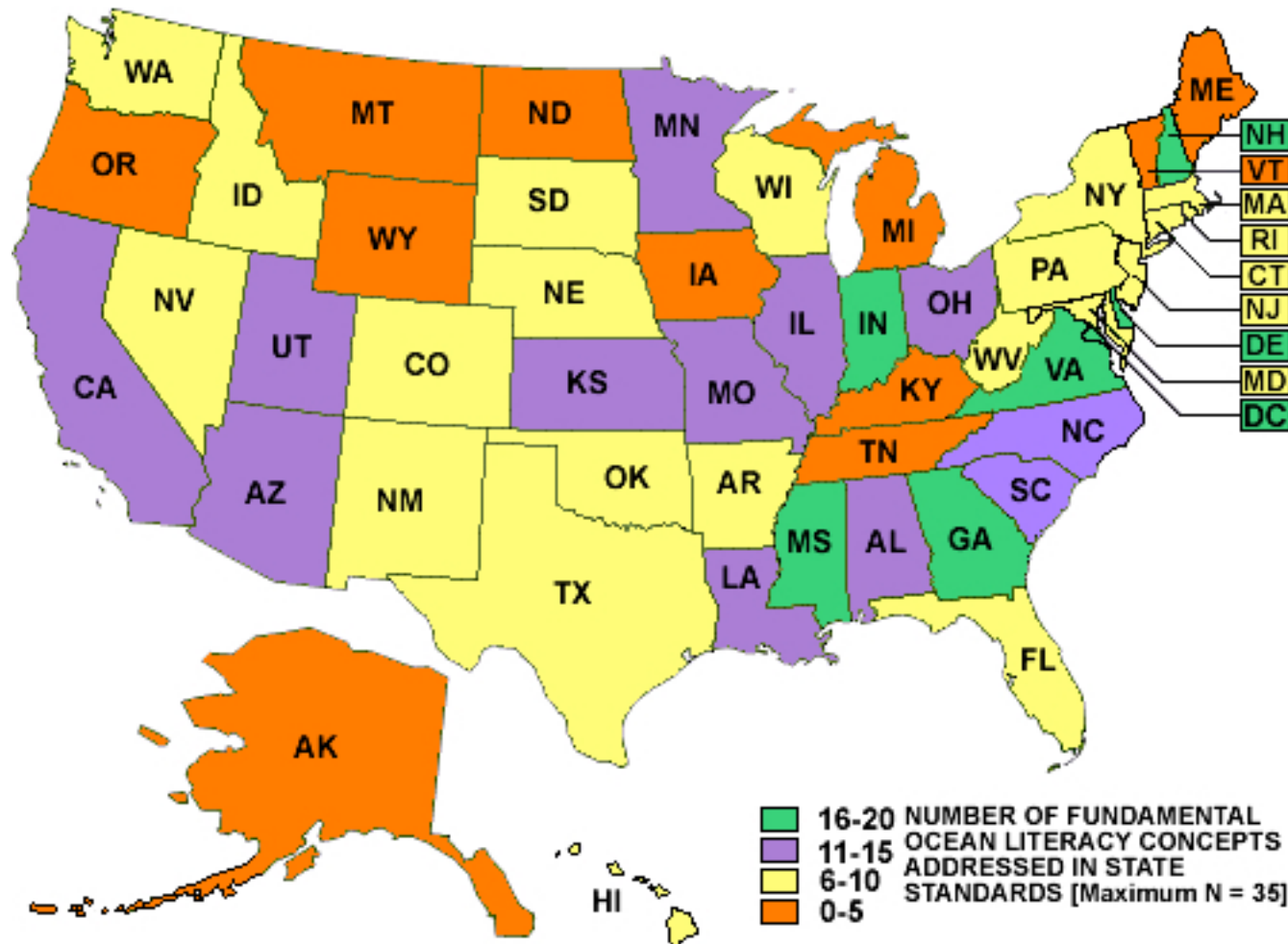
Further information

In addition, further information relating to access library and access resources can be found at www.ingetech.org/learn
www.ingetech.org or www.ingetech.org

Ocean Literacy

National Grade: D

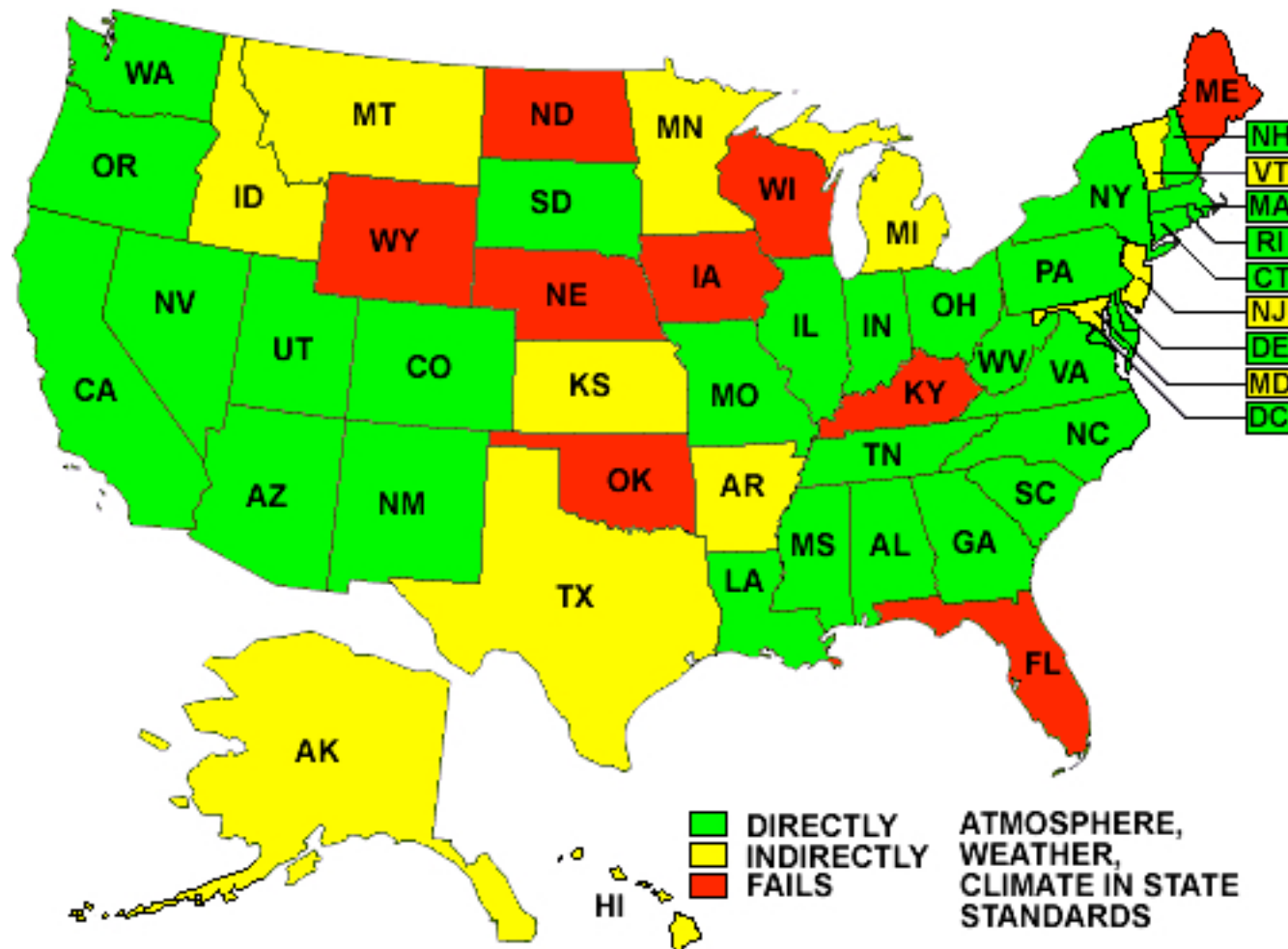
- Majority of states include some OL concepts
- Coastal states include slightly more OL concepts



Atmosphere, Weather, Climate

National Grade: C+

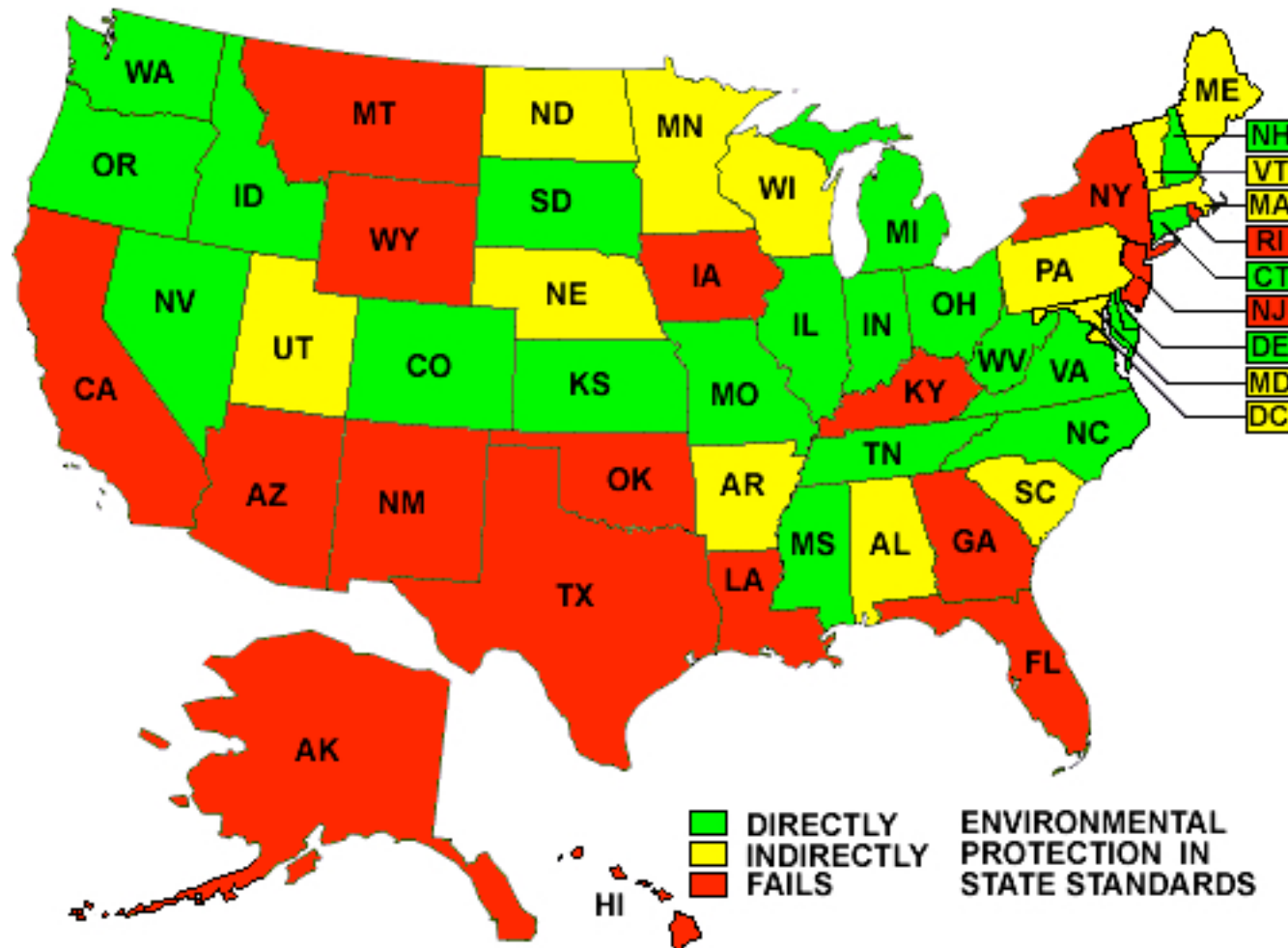
- Weather is a “classic” Earth science topic
- Florida standards do not mention “hurricanes”



Environmental Literacy

National Grade: C-

- Wide range of coverage across the country
- Applies Earth science to real world issues



Implementing the “Revolution” Improving Earth Science Education

1. Demonstrate that modern “revolutionary” Earth science perspectives and approaches result in deep student learning.
 - Develop and widely distribute model curricula.
 - Estuaries
 - Model Earth Science Lab Units
 - Other model curricula
 - Evaluate effectiveness of modern curricula and approaches.
2. Leverage key resources and research.
 - “America’s Lab Report” NRC
 - “Science Content and Standards for Ocean Literacy”
 - “National Science Education Standards” NRC

Implementing the “Revolution” Improving Earth Science Education

3. Participate in state standards revision processes.
4. Influence state and national assessments--content and format.
5. Ensure that Web-based access to data and analysis tools are usable by the K-12 education community.
6. Tirelessly persist in promoting change as improvement will occur in increments.